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16. *G. linkii* Spreng.—Both the inner and outer peridia at first fleshy then rigid and multifid.

Schweinitz found this species not rare in Pennsylvania; he declares it does not belong to the Geasters and gives it as *Actinodermium sternbeckii* Spf. He says it frequently grows cæspitosely, 3–4 individuals connected by roots; the expanded segments sometimes attain a breadth of more than half a foot. It must be a remarkable fungus.

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ON CATAGENESIS.[1]

BY E. D. COPE.

I. THE EVOLUTION OF ORGANISMS.

THE general proposition that life has preceded organization in the order of time, may be regarded as established. It follows necessarily from the fact which has been derived from palæontological investigation, that the simple forms have, with few sporadic exceptions, preceded the complex in the order of appearance on the earth. The history of the lowest and simplest animals will never be known on account of their perishability; but it is a safe inference from what is known, that the earliest forms of life were the rhizopods, whose organization is not even cellular, and includes no organs whatever. Yet these creatures are alive, and authors familiar with them agree that they display, among their vital qualities, evidences of some degree of sensibility.

The following propositions were laid down by Lamarck, as established by facts known to him, in 1809:[2]

I. "In every animal which has not passed the term of its development, the frequent and sustained employment of an organ, gradually strengthening it, develops and enlarges it, and gives it power proportional to the duration of its use; whilst the constant disuse of a like organ insensibly weakens it, deteriorates it, progressively reduces its functions, and finally causes it to disappear.

II. "All that nature acquires or loses in individuals, through the influence of circumstances to which the race has been exposed for a long time, either by the predominant ues of an organ or by the disuse of such part, she preserves by generation among new individuals which spring from it, provided the acquired changes be common to both sexes or to those which produce new individuals."

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[1] An address delivered before the Biological Section of the American Association for the Advancement of Science, at Philadelphia, September 4th, 1884, by E D. Cope, vice-president.

[2] Philosophie Zoölogique, Pt. I, p. 235 (Edit. 1830).

The same proposition was previously enunciated by Lamarck in the following condensed form (Recherches sur les Corps vivans, p. 50):

" It is not the organ, that is, the nature and form of the parts of the body, which have given origin to its habits and peculiar functions, but it is, on the contrary, its habits, its manner of life, and the circumstances in which individuals from which it came found themselves, which have, after a time, constituted the form of the body, the number and character of its organs, and the functions which it possesses."

Several years ago, not having read Lamarck, I characterized the above hypothesis as the " law of use and effort,"[1] and I have subsequently formulated the *modus operandi* of this law into two propositions. The first of these is, that animal structures have been produced, directly or indirectly, by animal movements, or the doctrine of *kinetogenesis ;* the second is, that as animal movements are primitively determined by sensibility, or consciousness, that consciousness has been, and is, one of the primary factors in the evolution of animal forms. This is the doctrine of *archæsthetism.* The doctrine of kinetogenesis is implied in the speculations of Lamarck in the following language (Philosophie Zoölogique, Ed. 1830, p. 239): "With regard to the circumstances which [nature] uses every day to vary that which she produces, one can say that they are inexhaustible. The principal arise from the influence of climates; from diverse temperatures of the atmosphere and of the environment generally; from diversity of location ; from habits, the most ordinary movements, and most frequent actions," &c. The influence of motion on development is involved in Spencer's theory of the origin of vertebræ by strains ;[2] and I have maintained the view that the various agencies in producing change mentioned by Lamarck are in the case of animals, simply stimuli to motion.[3] The immediate mechanical effect of motion on animal structure has been discussed in papers by Ryder, Hyatt, Clevenger and myself, and I have cited the evidence of vertebrate palæontology as conclusively proving such an effect."[1]

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[1] Method of Creation, Proceedings American Philosophical Society, 1871, p. 247.

[2] Principles of Biology, II, p, 195.

[3] On the Relation of Animal Motion to Animal Evolution, AMERICAN NATURALIST, Jan., 1878.

The object of the present paper is to pursue the question of the relation of sensibility to evolution, and to consider some of the consequences which it involves. It is scarcely necessary to observe that in the early stage which the subject presents at the present time, I can only point out the logical conclusions derivable from facts well established rather than any experimental discoveries not already known. And I will say here to those who object to the introduction of metaphysics into biology, that they cannot logically exclude the subject. As in one sense a function of nervous tissue, mind is one of the functions of the body. Its phenomena are everywhere present in the animal kingdom. Moreover, when studied in the inductive, *a posteriori* method, metaphysics is an exact science. As Bain observes, it is a good deal easier to foretell the actions of a man than those of the weather. It is only want of familiarity with the subject which can induce a biologist to exclude the science of mind from the field.

For the benefit of those who are not familiar with the doctrine of archæsthetism,[2] I give an outline of its implications. In the first place the hypothesis that consciousness had played a leading part in evolution would seem to be negatived by the well known facts of reflex action, automatism, etc., where acts are often unconsciously performed, and often performed in direct opposition to present stimuli. But while it is well understood that these phenomena are functions of organized structure, it is believed that the habits which they represent were inaugurated through the immediate agency of consciousness. It is not believed that a designed act can have been performed *for the first time*[3] without consciousness on the part of the animal, of the want which the act was designed to relieve or supply. This opinion accords with our knowledge of ourselves, and by irresistible inference, with our belief regarding other animals. From such familiar observation we also know that so soon as a movement of body or mind has been acquired by repetition, consciousness need no longer accompany the act. The act is said to be automatic when performed without exertion, either consciously or unconsciously, and in those functions now removed from the influence of the unconscious mind, such acts are called reflex. The *origin* of the acts is, however, believed to have been in consciousness, not only for the reasons above stated, but also from facts of still wider application. The hypothesis of archæsthetism then maintains that consciousness as well as life preceded organism, and has been the *primum mobile* in the creation of organic structure. This conclusion also flows from a due consideration of the nature of life. I think it possible to show that the true definition of life is, *energy directed by sensibility, or by a mechanism which has originated under the direction of sensibility*. If this be true, the two statements that life has preceded organism, and that consciousness has preceded organism are coëqual expressions.

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[1] The Evidence for Evolution in the History of the Extinct Mammalia, Am. Ass. Adv. Sci., 1883, p. 32.

[2] AMERICAN NATURALIST, 1882, p. 454.

[3] The same view is expressed by Ribot, Diseases of the Will, p. 38 (Humboldt, Libr).

II. CONSCIOUSNESS, ENERGY, AND MATTER.

Regarding for the time being the phenomena of life as energy primitively determined by consciousness, let us look more closely into the characteristics of this remarkable attribute. That consciousness, and therefore mind, is a property of matter, is a necessary truth, which to some minds seems difficult of acceptance. That it is not an attribute of all kinds of matter is clear enough, but to say that it is not an attribute of any kind of matter is to utter an unthinkable proposition. To my mind the absence of tridimensional matter is synonymous with nothingness or absolute vacuity. To say that phenomena have a material basis, is for me only another way of saying that they exist. It being granted then that consciousness is an attribute of matter, or a certain behavior of matter, it remains to trace its relation to energy, which is here used in the sense of motion. Consciousness is clearly not one of the known so-called inorganic forces. Objects which are hot, or luminous, or sonorous, are not, as is well known, on that account conscious. Consciousness is not then a necessary condition of energy. On the other hand, in order to be conscious, bodies must possess a suitable temperature, and must be suitably nourished. So energy is a necessary condition of consciousness. For this reason some thinkers regard consciousness as a form or species of energy. For my own part, in classification, I prefer to keep very different things apart. To classify consciousness with heat, light, sound, &c., does violence to my sense of fitness and to all proper definitions. This is well shown by Professor Clifford in the following passage: "It will be found excellent practice in the mental operations required by this doctrine, to imagine a train the forepart of which is an engine and three carriages linked with iron couplings, and the hind part three other carriages linked with iron couplings; the bond between the two parts being made out of the sentiments of amity subsisting between the stoker and the guard."[1] This satire, whether intentionally or not on the part of its learned author, expresses at once the distinctive character of consciousness *in esse* and the impossibility of dissociating it from energy *in posse.* For it is sufficiently clear that while the conscious feelings of the stoker and the guard could *by themselves* do nothing for the train, such a state is essential to the energy displayed by them when they are at work for its benefit. We all understand the absurdity of such expressions as the equivalency of force and matter, or the conversion of matter into force. They are not, however, more absurd than the corresponding proposition more frequently heard, that consciousness can be converted into energy, and *vice versa.*

The energetic side of consciousness, however, may be readily perceived by a little attention to its operations. Acts performed in consciousness involve a greater expenditure of energy than the *same acts* unconsciously performed. The difficulty of a given piece of labor is in direct proportion to its novelty; that is, is in direct proportion to the amount of endeavor we use in its performance. This is another way of saying that the labor is directly as the consciousness involved. Another evidence of the dynamic character of consciousness is its exclusive and therefore complementary character. Two opposite emotions cannot occupy the mind at the same moment of time. An emotion excludes all high intellectual work, and *vice versa.*

But there is no fact with which we are more familiar than that consciousness in some way determines the direction of the energy which it characterizes. The stimuli which affect the movements of animals at first only produce their results by transmission through the intermediation of consciousness. Without consciousness, education, habits, and designed movements, would be impossible. So far as we know, the instinct of hunger, which is at the foundation of animal being, is a state of consciousness in all animals. This incontestible fact is overlooked by the materialists properly so-called.

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[1] Scientific Basis of Morals, Humboldt Library Ed., p. 21.

On the other hand, as consciousness is an attribute of matter, it is of course subject to the laws of necessity to which matter and energy conform. For instance, it cannot cause two solid bodies to occupy the same space at the same time, nor can it add one body to one body and thus make three bodies. No more can it make ten foot pounds of energy out of five foot pounds of energy, and it cannot abolish time more than it can annihilate space. These are fundamental truths which are overlooked by a majority of mankind. Moreover, nothing is more common than to hear life or mind spoken of as though it of itself is a "substance," and not as it should be as an *attribute* or condition of substance or matter.

What is then the immediate action of consciousness in directing energy into one channel rather than another? To take an illustration: Why, from a purely mechanical point of view, is the adductor muscle of the right side of the horse's tail contracted to brush away the stinging fly from the right side of the horse's body rather than the left adductor muscle? Why was the contraction-provoking energy deflected in to the right interspinal motor nerves rather than into those of the left side? Why is the ear of the horse turned forwards to catch the sound in front of him and backwards to gather the sound coming from behind? The first crude thought is, that consciousness supplies another energy which turns aside the course of the energy required to produce the muscular contraction; either as the man with the rein in his hand turns aside the horse's head, or as the shield he holds deflects a moving body. But consciousness, *per se*, that is, regarding it in its proper and distinctive definition, is not itself a force (= energy). How then can it exercise energy? Certainly no more than the bare goodwill of the train hands can pull the train. Such an explanation is to admit the possibility of making something out of nothing.

III. THE RETROGRADE METAMORPHOSIS OF ENERGY.

The key to many weighty and mysterious phenomena lies in the explanation of the so-called voluntary movements of animals. I say "so-called," because true will is not at all involved in the question. I mean the acts directed by consciousness, the acts which would not take place at all if the animal were unconscious. That there are many such acts you well know. The explanation can only be found in a simple acceptance of the fact as it is, in the thesis, that *energy can be conscious.* If true, this is an ultimate fact, neither more nor less difficult to comprehend than the nature of energy or matter in their ultimate analyses. But how is such a hypothesis to be reconciled with the facts of nature, where consciousness plays a part so infinitesimally small? The explanation lies close at hand, and has already been referred to. *Energy become automatic is no longer conscious,* or is about to become unconscious. That this is the case is matter of everyday observation on ourselves and on other animals. What the molecular conditions of consciousness are, is one of the problems of the future, and for us a very interesting one. One thing is certain, the organization of the mechanism of habits is its enemy. *It is clear that in animals, energy, on the loss of consciousness, undergoes a retrograde metamorphosis,* as it does later in the history of organized beings on their death. This loss of consciousness is first succeeded by the so-called involuntary and automatic functions of animals. According to the law of catagenesis, the vegetative and other vital functions of animals and plants are a later product of the retrograde metamorphosis of energy. With death, energy falls to the level of the polar tensions of chemism, and the regular and symmetrical movements of molecules in the crystallization of its inorganic products. Let us now trace in more detail the energies displayed by animals and plants.

It has been already advanced (see page 971) that the phenomena of growth-force, which are especially characteristic of living things, originated in the direction given to nutrition by consciousness and by the automatic movements derived from it. There remain, however, some other phenomena which do not yield so readily to this analysis. These are: first, the conversion by animals of dead into living protoplasm; second, the conversion of inorganic substances into protoplasm by plants; and third, the manufacture of the so-called organic compounds from the inorganic by plants. To these points we may return again. It is also well known that living animal organisms act as producers, by conversion, of various kinds of inorganic energy, as heat, light, sound, electricity, motion, etc. It is the uses to which these forces are put by the animal organism, the evident design in the occasion of their production, that gives them the stamp of organic life. We recognize the specific utility of the secretions of the glands, the appropriate distribution of the products of digestion, and adaptation of muscular motion to many uses. The increase of heat to protect against depression of temperature; the light to direct the sexes to each other; the electricity as a defence against enemies; display unmistakably the same utility. We must not only believe that these functions of animals were originally used by them, under stimulus, for their benefit, but if life preceded organism, that the molar mechanism which does the work, has developed as the result of the animal's exertions under stimuli. This will especially apply to the mechanism for the production of motion and sound. Heat, light, chemism and electricity doubtless result from molecular aptitudes inherent in the constitution of protoplasm. But the first and last production of even these phenomena is dependent on the motions of the animal in obtaining and assimilating nutrition. For without nutrition all energy would speedily cease. Now the motion required for the obtaining of nutrition has its origin in the sensation of hunger. So even for the first steps necessary to the production of inorganic forces in animals, we are brought back to a primitive consciousness.

To regard consciousness as the primitive condition of energy, contemplates an order of evolution in large degree the reverse of the one which is ordinarily entertained. The usual view is, that life is a derivative from inorganic energies as a result of high or complex molecular organization, and that consciousness (=sensibility) is the ultimate outcome of the nervous or equivalent energy possessed by living bodies. The failure of the attempts to demonstrate spontaneous generation, will prove, if continued, fatal to this theory. Nevertheless the order cannot be absolutely reversed. Such a proceeding is negatived by the facts of the necessary dependence of the animal kingdom on the vegetable, and the vegetable on the inorganic for nutrition, and consequently for existence. So the animal organism could not have existed prior to the vegetable, nor the vegetable prior to the mineral. The explanation is found in the wide application of the "doctrine of the unspecialized,"[1] so clearly demonstrated by palæontology.

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[1] The term specialized, introduced into biology by Professor Dana, has been used in connection with energy in creation by the author, *Penn Monthly*, 1875, p. 569.

From this point of view creation consists in specialization, an expression which describes the specific action of the general principle described by Spencer as the conversion of the homogeneous into the heterogeneous. To be more explicit, it consists of the production of mechanism out of no mechanism, of different kinds of energy out of one kind of energy. The material basis of consciousness must then be a generalized substance which does not display the more automatic and the polar forms of energy. From a physical standpoint protoplasm is such a substance. Its instability indicates weakness of chemical energy also, which suggests that the complexity of its molecule may be due to some form of energy not properly chemical. The readiness with which it undergoes retrograde metamorphosis shows that it is not self-sustaining, and furnishes a good illustration of creation of specialized substances by a running down in the scale of being. Loew and Bokorny[1] suggest that "the cause of the living movements in protoplasm is to be sought for in the intense atomic movements, and therefore easy metamorphosis of its aldehyde groups of components;" the molecular movements becoming molar, to use the language of Lester Ward. The position which I now present requires the reversal of the relations of these phenomena. Generalized matter must be supposed to be capable of more varied molecular movements than specialized matter, and it is believed that the most intense of all such movements are those of brain tissue in mental action, which are furthest removed of all from molar movements. From this point of view, when molar movements are derived from molecular movements, it is by a process of running down of energy, not of elevation; by an increase of the distance from mental energy, not an approximation to it.

The fact that the physical basis of consciousness is composed of four substances, which are respectively a monad, a dyad, a triad and a tetrad, doubtless has something to do, as I have suggested,[2] with its exhibition of this remarkable attribute. It might be supposed that the presence of carbon had the effect of restraining the chemical and physical molecular tendencies of the three other substances. From this standing-ground we may imagine that other substances besides protoplasm might support consciousness and life. In other parts of the universe, other substances they would have to be, if consciousness exist there.

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[1] Die Chemische Kraftquelle in Lebenden Protoplasma, von O. Loew u. T. Bokorny, Munich, 1882, I.

[2] *Penn Monthly*, 1875, p. 574.

The manner in which protoplasm is made at the present time is highly suggestive. It is manufactured by living plants out of inorganic matter, the hydrogen, carbon, nitrogen and oxygen contained in the atmosphere and in the earth. As dead plants will not perform this function, this action is regarded as in some way due to the presence of life. The energy peculiar to living protoplasm, and derived primarily in part only from the sun's rays, directs energy so that the complex molecular aggregation protoplasm is the result. This is the only known method of manufacture from inorganic matter, of this substance. The first piece of protoplasm had however no paternal protoplasm from which to derive its being. The protoplasm-producing energy must, therefore, have previously existed in some form of matter not protoplasm. This is also suggested by the fact that it really antagonizes the chemical forces, and might be called, from this fact, *antichemism*. The protoplasm-sustaining energy of animal protoplasm may be a less energetic derivative, or *vice versa*. In terms of the theory of catagenesis, the plant life is a derivative of the primitive life, and it has retained enough of the primitive quality of self-maintenance to prevent it from running down into forms of energy which are below the life level; that is, such as are of the inorganic chemical type, or the crystalline physical type. A part of the energy does so run down, as can be seen in the few automatic movements of plants, and the phosphorescence of some. Also symmetrical crystals are made by some. But M. Pasteur has shown[1] that whenever the crystals are of the organic type, *i. e.*, contain carbon, they are not symmetrical but are unilateral, or, as he terms them, dissymmetrical. This indicates that the presence of carbon has restrained, a little, the absolute symmetrical automatism of the formative force.

IV. ORIGIN OF LIFE ON THE EARTH.

If then some form of matter other than protoplasm has been capable of sustaining the essential energy of life, it remains for future research to detect it, and to ascertain whether it has long existed as part of the earth's material substance or not. The heat of the earlier stages of our planet may have forbidden its presence, or it may not. If it were excluded from the earth in its first stages, we may recognize the validity of Sir William Thomson's suggestion that the physical basis of life may have reached us from some other region of the cosmos by transportation on a meteorite. If protoplasm in any form were essential to the introduction of life on our planet, this hypothesis becomes a necessary truth. Here let me refer to the fact that hydrocarbonaceous substances have been discovered in meteorites. Here also the remarkable discovery of Huggins claims attention.[1] This veteran spectroscopist has detected the lines of some hydrocarbon vapor in the spectra of interplanetary spaces. The significance of this discovery is at once perceived if we believe that hydrocarbons are only produced under the direction of life.[2]

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[1] *Revue Scientifique*, 1884, Jan., p. 2.

Granting the existence of living protoplasm on the earth, there is little doubt that we have some of its earliest forms still with us. From these simplest of living beings both vegetable and animal kingdoms have been derived. But how was the distinction between the two lines of development, now so widely divergent, originally produced? The process is not difficult to imagine. The original plastid dissolved the salts of the earth and appropriated the gases of the atmosphere and built for itself more protoplasm. Its energy was sufficient to overcome the chemism that binds the molecules of nitrogen and hydrogen in ammonia, and of carbon and oxygen in carbonic dioxide. It apparently communicated to these molecules its own method of being, and raised the type of energy from the polar non-vital to the adaptive vital by the process. Thus it transformed the dead mineral world, perhaps by a process of invasion, as when a fire communicates itself from burning to not burning combustible material. Thus it has been doing ever since, but it has redeposited some of its gathered stores in various non-vital forms. Some of these are in organic forms, as cellulose; others are crystals imprisoned in its cells; while others are amorphous, as waxes, resins and oils. But consciousness apparently early abandoned the vegetable line. Doubtless all the energies of vegetable protoplasm soon became automatic. The plants in general, in the persons of their protist ancestors, soon left a free-swimming life and became sessile. Their lives thus became parasitic, more automatic, and in one sense degenerate.

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[1] See address of C. W. Siemens, Prest. British Ass. Adv. Science, 1882; *Nature*, 1882, p. 400.

[2] Says Mr. S. F. Peckham (*American Journal of Science and Arts*, 1884, p. 105), on the origin of bitumens: "These chemical theories [of the origin of bitumen] are supported by great names, and are based upon very elaborate researches, but they require the assumption of operations nowhere witnessed in nature or known to technology. * * In the chemical processes of nature complex organic compounds pass to simpler forms, of which operation marsh gas, like asphaltum, is a resultant and never the crude material upon which decomposing forces act."

The animal line may have originated in this wise. Some individual protists, perhaps accidentally, devoured some of their fellows. The easy nutrition which ensued was probably pleasurable, and once enjoyed was repeated, and soon became a habit. The excess of energy thus saved from the laborious process of making protoplasm was available as the vehicle of an extended consciousness. From that day to this, consciousness has abandoned few if any members of the animal kingdom. In many of them it has specialized into more or less mind. Organization to subserve its needs has achieved a multifarious development. There is abundant evidence to show that the permanent and the successful forms have ever been those in which motion and sensibility have been preserved, and most highly developed.

This review of the history of living organisms has been epitomized in the following language:[1] "Evolution of living types is then a succession of elevation of platforms, on which succeeding ones have built. The history of one horizon of life is that its own completion but prepares the way for a higher one, furnishing the latter with conditions of a still further development. Thus the vegetable kingdom died, so to speak, that the animal kingdom might live, having descended from an animal stage to subserve the function of food for animals. The successive types of animals first stimulated the development of the most susceptible to the conflict, in the struggle for existence, and afterwards furnished them with food."

V. CATAGENESIS OF INORGANIC ENERGY.

If the principles adopted in the preceding pages be true, it is highly probable that *all forms* of energy have originated in the process of running down or specialization from the primitive energy.

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[1] AMERICAN NATURALIST, 1880, p. 266.

In the department of physics I am not at home, and touch upon it merely to carry out to a necessary conclusion the hypothesis presented in the preceding pages. It may be that physicists and chemists may find value in the suggestions which come from the side of biology. A cursory perusal of the general hypotheses current in these departments, shows that the door is wide open to receive light from this quarter. What can be offered here is of the vaguest, yet it may suggest thought and research in some minds.

In the first place it is highly probable that one of the problems to be solved by the physicists of the present and future, is that of a true genealogy of the different kinds of energy. In this connection a leading question will be the determination of the essential differences between the different forms of energy, and the material conditions which cause the metamorphosis of one kind of energy into another.

In constructing a genealogy of energies, it must be observed that we will probably obtain, not a single line of succession, but several lines of varying lengths. It must also be remembered, that as in the forms of the material world which are their expression, a greater or less extensive exhibition of all the types remains to the present day.

That the tendency of purely inorganic energy is to " run down," in all except possibly some electric operations, is well known. Inorganic chemical activity constantly tends to make simpler compounds out of the more complex, and to end in a satisfaction of affinities which cannot be further disturbed except by access of additional energy. In chemical reaction the preference of energy is to create solid precipitates. In the field of the physical forces we are met by the same phenomenon of running down. All inorganic energies or modes of motion tend to be ultimately converted into heat, and heat is being steadily dissipated into space. Therefore the result has been and will be the creation of the mineral kingdom; of the rocks and fluids that constitute the masses of the worlds.

The process of creation by the retrograde metamorphosis of energy, or what is the same thing, by the specialization of energy may be called *catagenesis*. It may be denied, however, that this process results in a specialization of energy. The vital energies are often regarded as the most special, and the inorganic as the most simple. If we regard them, however, solely in the light of the essential nature of energy, *i. e.*, power, we must see that the chemical and physical forces are most specialized. The range of each species is absolutely limited to one kind of effect, and their diversity from each other is total. How different this from the versatility of the vital energy. It seems to dominate all forms of conversion of energy, by the mechanisms which it has, by evolution, constructed. Thus if the inorganic forces are the products of a primitive condition of energy which had the essential characteristics of vital energy, it has been by a process of specialization. As we have seen, it is this specialization which is everywhere inconsistent with life.

With these preliminary remarks we may now consider very tentatively the relations of the different kinds of energy to each other and to consciousness. In practice it is sometimes difficult to draw the line between conscious and unconscious states of energy. One reason is, that although a given form of energy may be unconscious, consciousness may apprehend the action by perceiving its results. The distinction is rendered clearer by the reflection that we can perceive by sight or touch any action of the body of whatever character. The energy of the conscious type is therefore altogether mental. The relations may be expressed as follows:

A. Designed (always molecular).	*Examples.*
I. Conscious.	
1. Involving effort	"Voluntary" acts.
2. Not involving effort	Passive perception. Conscious automatism.
II. Unconscious.	
3. Involving mental process	Unconscious automatic.
4. Not involving mental process	Reflex.
B. Not designed.	
I. Molecular.	
5. Electric,	
6. Chemical,	Crystallific and non-crystallific.
7. Physical,	
II. Molar.	
8. Cosmic.	

The only strictly molar energies of the above list are the cosmical movements of the heavenly bodies. The others are molecular, although they give rise to molar movements, as those of the muscles, of magnetism, &c. Some molar movements of organic beings are not, *in their last phases*, designed; as those produced by nervous diseases.

The transition between the organic and the inorganic energies may be possibly found in the electric group. Its influence on life, its production of contractions in protoplasm, and its resemblance to nerve force, are well known. It also compels chemical unions otherwise impracticable, thus resembling the energy of the protoplasm of plants, whose energy in actively resisting the disintegrating inorganic forces of nature is so well known. Perhaps this type of force is an early-born of the primitive energy, one which has not descended so far in the scale, as the chemism which holds so large a part of nature in the embrace of death.

Vibration is inseparable from our ideas of motion or energy, not excluding conscious energy. There are reasons for supposing that in the latter type of activity the vibrations are the most rapid of all those characteristic of the forces. A center of such vibrations in generalized matter would radiate them in all directions. With radiant divergence the wave lengths would become longer, and their rate of movement slower. In the differing rates of vibrations we may trace not only the different forms of energy, but diverse results in material aggregations. Such may have been the origin of the specialization of energy and of matter which we behold in nature.

Such thoughts arise unbidden as a remote but still a legitimate induction, from a study of the wonderful phenomenon of animal motion; a phenomenon everywhere present, yet one which retreats, as we pursue it, into the dimness of the origin of things. And when we follow it to its fountain head, we seem to have reached the origin of all energy, and it turns upon us, the king and master of the worlds.

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THE CRYSTALLINE ROCKS OF THE NORTHWEST.[1]

BY N. H. WINCHELL.

I DESIRE to call the attention of Section E to some of the interesting problems that beset the geologist who undertakes to study the crystalline rocks of the Northwest, and especially that part of the Northwest which is included in the State of

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[1] Address delivered before the section of geology and geography of the Amer. Assoc. Adv. Science at Philadelphia, Sept. 4, 1884.